(a) providing at least 500 reaction vessels organized into at least first and second sub-arrays;

(b) adding reactants to each of the reaction vessels in a manner such that, when reacted, the reactants form the compounds of the sub-arrays in the array, wherein each reaction vessel contains substantially only one compound and such that the compounds composing each sub-array differ from one another by one change in a structural diversity element; and

(c) concurrently reacting the contents of the reaction vessels under appropriate solution-phase conditions in one or more cycles to form all compounds of the sub-arrays in the array.

11. (Five Times Amended) A method of making a spatially-addressable combinatorial array of at least 500 compounds in solution in multiple cycles, said method comprising the steps of:

(a) apportioning into a plurality of reaction vessels that are identifiable by their spatial addresses (i) a first plurality of reactants, each reactant comprising a same first reactive group and a different first structural diversity element such that the reactants composing the first plurality differ from one another, with one first reactant per reaction vessel; and (ii) a second reactant comprising a second reactive group and a second structural diversity element, with one second reactant per reaction vessel; and

(b) concurrently reacting said first and second reactants in each of the plurality of reaction vessels under solution phase conditions wherein the first and second reactive groups react with one another by an addition reaction to form a compound; and

(c) repeating steps (a) and (b), thus forming the combinatorial array of at least 500 different compounds in solution;

wherein each reaction vessel contains substantially only one compound,

wherein each compound composing the combinatorial array comprises a same common linear, branched, or cyclic molecular core comprising at least three atoms of carbon, nitrogen, oxygen, phosphorus or sulfur having the first and second structural diversity elements attached thereto, and further wherein the compounds composing the array differ from one another by at least one change in a structural diversity element.